

peratures for the month generally occurred from the 11th to the 14th, at most of the stations east of the Rocky Mountains, during the movement of storms No. IV, V, VI and VII.

*Minimum Temperatures* below  $-20^{\circ}$  are as follows: Bismarck,  $-23^{\circ}$ ; Breckenridge,  $-23^{\circ}$ ; Denver,  $-25^{\circ}$ ; Duluth,  $-30^{\circ}$ ; Fort Sully,  $-26^{\circ}$ ; La Crosse,  $-24^{\circ}$ ; North Platte,  $-25^{\circ}$ ; Pembina,  $-49^{\circ}$ ; Pike's Peak,  $-21^{\circ}$ ; St. Paul,  $-27^{\circ}$ . The minimum above  $+20^{\circ}$  have been Charleston, 23; Galveston, 26; Indianola, 23; Jacksonville, 24; Key West, 45; Mobile, 21; New Orleans, 28; Portland, Or., 24; San Diego, 43; San Francisco, 42; Savannah 20 and Tybee Island 25. The minimum temperatures have attended the progress of areas of high pressure and clear, dry weather, as given in the previous chapter. The principal epochs of low temperature have been as follows: 1st in Fla.; 2nd, Ga., S. C. and Fla.; 3rd, Fla.; 4th, Fla.; 6th, Ga., Fla.; 7th and 8th, Dak., Mo.; 9th, Ill., Ohio, Iowa, Minn., Ind., Tenn., Wis., Ky.; 10th, N. J., Md., N. C., Ohio, Mich., Pa., Va., W. Va., N. Y., D. C.; 11th, Cal.; 14th, Utah; 15th, Cal.; 16th, Mich., N. Y., Minn., Or.; 17th, N. Y., Mich., Mass., Vt., N. J., Me., Conn., R. I., Cal.; 18th, Utah, Cal.; 23rd, Cal., Montana, Tex.; 24th, Wy. T., Col., N. M.; 25th, N. Y., Wy. T., Tex., Mass.; 26th, Dak., Kan., Neb.; 27th, Dak.; 28th, Col.; 29th, Dak., Tex., Kan., Neb.; 30th, Minn., Ill., Dak., Ind. T., Tenn., Ga., Ala., Miss., La., Neb.; 31st, Tenn.

*Ranges of Temperature*—The largest ranges of temperatures for the month have been: Denver,  $93^{\circ}$ ; North Platte,  $87^{\circ}$ ; Dodge City and Pembina,  $84^{\circ}$ ; Fort Sully,  $82^{\circ}$ ; Fort Gibson,  $77^{\circ}$ ; Breckenridge,  $75^{\circ}$ ; Yankton,  $72^{\circ}$ ; Leavenworth and Duluth,  $69^{\circ}$ ; St. Paul,  $68^{\circ}$ ; Bismarck, Denison, Keokuk, La Crosse and Virginia City,  $67^{\circ}$ . The smallest ranges have been: San Francisco,  $22^{\circ}$ ; Portland, Or. and Salt Lake City,  $32^{\circ}$ ; San Diego,  $34^{\circ}$ ; Tybee Island,  $38^{\circ}$ ; Buffalo, Charleston, Key West and New Orleans,  $42^{\circ}$ ; Cape Lookout, Sandy Hook and Smithville,  $43^{\circ}$ ; Atlantic City, Barnegat and Galveston,  $44^{\circ}$ .

*Frosts* have occurred as far southward as the Gulf States in every day of the month except the following: 8th, 11th, 14th, 21st, 22nd, 23rd and 24th. The first period of cold, which continued from the 1st to the 6th, is especially reported on by the Observer at Pania Rassa, according to whom, at that place, scarcely anything escaped being injured by the cold. Large quantities of fish, of all sizes and kinds, were killed by the cold water, and cast up on the beach daily. Snow fell for about five minutes on the morning of the 1st. Within a region of fifty miles radius frost occurred nearly every day.

## PRECIPITATION.

*In General*—The distribution of the total amount of rain or melted snow for December is shown upon chart No. III. The great irregularity in snow-fall and its drifting by the wind, as well as the want of uniformity in methods of measuring the dry and the melted snow render the isohyetal lines, open to some doubt; but, in general, it appears that less than an inch fell in Minn., Iowa, Ill., and westward to the Rocky Mountains, producing a large deficiency in this region as compared with normal values. The deficiency is also quite decided in the Ohio valley and Tennessee and for the Middle Atlantic States. A small deficiency is reported from the Upper and Lower Lake regions, Minnesota, New England and the Western Gulf States, but a large excess has fallen in the Eastern Gulf and South Atlantic States. The deficiency in New England and the Middle Atlantic States was to a large extent made up for by the storm of January 1st, 1877. The most remarkable feature of the map is the remarkable deficiency in Or. and Cal. The normal values for these regions are approximately as follows: San Diego, 2 inches, San Francisco, 5 inches and Portland, Or., 7 inches. These notable deficiencies are to be taken in connection with the high temperature and the high barometric pressures that have also prevailed there.

*Stations reporting no rain during month*.—No rain at all is reported from four stations in the immediate neighborhood of San Francisco, Cal., as also from Ft. Clarke, on the Rio Grande, Texas. Numerous stations report one-tenth inch of rain, or less, near the boundary between Kansas and Nebraska.

*Stations reporting heavy rains or snow* are as follows: Cape Lookout, 6.15; Jacksonville, 6.15; Mobile, 7.18; New Orleans, 9.57; St. Marks, 8.51; Eaton Rouge, 2 inches of rain fell from noon to 10 p. m. of the 31st. Heavy snows were reported as follows: Monticello, Ark., 28th, 7 inches; 31st, 21 inches; Lenore, N. C., 24th and 25th, 11 inches; Spartanburg, S. C., 23rd, 24th and 25th, 10 inches; McMinville, Tenn., 28th and 29th, 14 inches, heaviest snow ever known; Raleigh, N. C., 25th, 13 inches, heaviest snow storm ever known in that vicinity; Memphis, Tenn., 28th, 8½ inches; Shelbyville, Tenn., 28th, the heaviest snow-fall since the 15th and 16th of May, 1843, when the fall was 21 inches, and very uniform. The observer at Hwassie College, Tenn., reports that the snow-fall of December 31st and January 1st amounted, in 17 hours, to 20 inches, being the most remarkable snow-fall known to the inhabitants.

*Total snow-fall for month*.—Ark., 12 to 28 inches; Conn., 11 to 38; Cal., 4; Dakota, 5; Del., 4½; Ga., 1; Ill., 2 to 26; Ind., 3 to 24; Iowa, 2 to 8; Kan., 1 to 7; Ky., 10 to 14; La., 12; Maine, 32 to 43; Md., 8 to 15; Mass., 12 to 36; Mich., 15 to 24; Mo., 1 to 4; Neb., 1 to 5½; N. H., 39 to 42; N. J., 6 to 18; N. Y., 7 to 10; N. C., 6 to 26; Ohio, 8 to 42; Penn., 4 to 28; R. I., 18; Tenn., 17 to 29; Tex., 8; Utah, 10; Vt., 18 to 55; Va., 4 to 18; W. Va., 28; Wis., 3 to 21.

*Rainy Days.*—The number of days, during the month, on which some rain or snow fell is as follows: Alpena, 27; Buffalo, 26; Cleveland, 25; Detroit, 21; Erie, 25; Grand Haven, 22; Morgantown, 21; Oswego, 25; Pittsburgh, 22; Port Huron, 27; Rochester, 27; Toledo, 21—from which it will be seen that in the Lake region the precipitation has been remarkably frequent. The number of days on which precipitation has occurred in the remaining districts is as follows: New England, 9 to 18; Middle Atlantic States, 6 to 14; South Atlantic States, 9 to 13; Gulf States, 6 to 18; Ohio valley and Tennessee, 5 to 15; Northwest, 3 to 17; Rocky Mountain stations, 5 to 11.

*Cloudy Days.*—The number of days on which the cloudiness has equalled eight on a scale of ten, as reported by voluntary observers, ranges as follows: New England, 6 to 25; Middle States, 4 to 25; South Atlantic States, 4 to 13; Gulf States, 5 to 17; Ohio valley and Tennessee, 6 to 20; Upper Lake region, 15 to 22; Northwest, 1 to 13.

*Drouths.*—A scarcity of water is reported from some portions of the Middle States, New England and the Northwest, owing to the continued cold weather, which has prevented the snow from melting. The lack of rain in California has caused some apprehensions on the part of farmers that agricultural interests may suffer.

## RELATIVE HUMIDITY.

The mean relative humidity for the month, as reported from the Signal Service stations, ranges as follows: in New England, 69 to 78 per cent.; Middle Atlantic States, 66 to 80; South Atlantic States, 62 to 74; Gulf States, 57 to 74; Indian Territory, Arkansas and Tennessee, 55 to 72; Lower Lake region, 72 to 80; Upper Lake region, 61 to 79; Ohio valley and Northwest, 64 to 74; Cheyenne, 66; Denver, 51; Pike's Peak, 65; Santa Fe, 46; Virginia City, 62; Salt Lake City, 89; Portland, Or., 82; San Francisco, 66; San Diego, 58. The unusually moist atmosphere at Salt Lake City was accompanied by a dense fog, which hung over the station almost continually from the 5th until the 20th.

## WINDS.

*Prevailing winds.*—These are shown by the arrows on chart No. II. They have very generally been from N., NW. or W. over the entire country from the Rocky Mountains eastward to the Atlantic, except in Tennessee and the Ohio valley, where they have been more variable.

*Total movement of the air.*—The following are the largest total movements of the air as recorded at the Signal Service stations: Pike's Peak, 19,641 miles; Cape May, 16,407; Sandy Hook, 14,954; Thatcher's Island, 13,669; Kitty Hawk, 12,166; Cape Lookout, 11,737; Barnegat, 11,445; Erie, 11,289; Grand Haven, 10,209; Wood's Hole, 10,168. The smallest movements have occurred at the following stations: Salt Lake City, 1,636 miles; Nashville, 2,648; Virginia City, 2,684; Portland, Or., 2,727; Dubuque, 2,854; San Diego, 3,079; San Francisco, 3,115; Shreveport, 3,326.

*Highest Winds.*—Among the highest hourly wind velocities reported from Signal Service stations are the following: Boston, 29th, E. 57; Buffalo, 15th, W. 60; Bismarck, — 64; Cape May, 9th, W. 72, 17th, NW. 60; Eastport, 18th, SE. 54, 29th, E. 69; Erie, 16th, W. 52; Grand Haven, 15th, SW. 66; Knoxville, 8th, SW. 54; Malone, 15th, S. 52; Marquette, 9th, W. 54; Milwaukee, 15th, W. 54; Morgantown, 8th, W. 54; New York, 9th, W. 60, 16th, NW. 60; Newport, 9th, SW. 60; Pembina, 15th, NW. 54; Pike's Peak, 7th, — 66, 29th, — 90; Sandy Hook, 9th, W. 84, 16th, NW. 63, 18th, NW. 60, 30th, W. 68; Thatcher's Island, 29th, E. 60. The observer at Detroit reports that during the storm of the 15th and 16th, in which the wind attained a maximum velocity of 35 miles per hour from the W., the changes in pressure and temperature were unprecedented in respect to magnitude and rapidity. A fall in pressure of .20 of an inch was recorded in two hours, followed by a rise of .86 in eight hours. The temperature rose 17° in eight hours and subsequently fell 32° in the same interval. The approach of this storm was fully anticipated by the Cautionary Signals. The high winds accompanying low barometer No. V, appear to have been very severe in Newfoundland. According to reports from St. Johns falling barometer and gales continued throughout the 13th, the barometer falling to 28.60 at 9 a. m. A *water-spout* was observed at Wilmington, N. C., on the 29th, at 8 a. m. At Augusta, Ill., a violent *whirlwind* occurred on the 8th, at 9 a. m.

## VERIFICATIONS.

*Indications.*—The detailed comparison of the tri-daily weather indications with the telegraphic reports for the succeeding 24 hours shows a percentage of verifications of 88.1 and a percentage of omissions of 0.9 in detail. The percentages have been as follows: for weather, 95.2; wind, 86.6; temperature, 85.6; barometer, 85.0. The geographical distribution of the verifications has been as follows: New Eng. 88.9; Mid. States, 90.2; S. Atlantic, 90.4; E. Gulf States, 89.0; W. Gulf States, 87.8; Lower Lake region, 89.3; Up. Lake region, 88.1; Tenn. and the Ohio valley, 90.0; Up. Miss. valley, 85.1; Lower Mo. valley, 80.2.

*Cautionary Signals.*—There have been displayed during the month at U. S. S. stations 192 cautionary storm signals; of these 142 were verified at the stations, and 19 others, or 83 per cent. in all, verified within